

# A new genus and species of golden coral (Anthozoa, Octocorallia, Chrysogorgiidae) from the Northwest Atlantic

Stephen D. Cairns<sup>1</sup>, Ralf T. S. Cordeiro<sup>2</sup>

**1** Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, PO Box 37012, MRC 163, Washington, DC 20013-7012, USA **2** Programa de Pós-Graduação em Biologia Animal, Universidade Federal de Pernambuco, Av. Prof. Moraes Rego, 1235, Cidade Universitária, Recife, PE, CEP: 50670-901, Brazil

Corresponding author: Stephen D. Cairns (cairnss@si.edu)

---

Academic editor: B. W. Hoeksema | Received 9 February 2017 | Accepted 2 April 2017 | Published 12 April 2017

<http://zoobank.org/A3F5117B-BEAF-4F6C-B6E9-0C45EAC261A9>

---

**Citation:** Cairns SD, Cordeiro RTS (2017) A new genus and species of golden coral (Anthozoa, Octocorallia, Chrysogorgiidae) from the Northwest Atlantic. ZooKeys 668: 1–10. <https://doi.org/10.3897/zookeys.668.12203>

---

## Abstract

A new genus and species of unbranched golden coral, *Flagelligorgia gracilis*, is described based on several specimens collected off the southeastern coast of the United States. The genus is provisionally included in the family Chrysogorgiidae, pending molecular confirmation. *Flagelligorgia* morphologically resembles other unbranched chrysogorgiids, such as *Distichogorgia*, *Chalcogorgia*, *Helicogorgia* and *Radicipes*, to which it is compared. The type species is illustrated and its distribution mapped.

## Keywords

*Flagelligorgia gracilis*, unbranched octocoral, biserial polyp arrangement, *Radicipes*, southeastern USA

## Introduction

Chrysogorgiids form a polyphyletic family of octocorals (Pante et al. 2012), which is distributed in all oceans throughout the world (Watling et al. 2011). Most of its genera are in need of revision, some of which require reallocation into new families (Pante et al. 2012). In the course of doing a revision of the genus *Radicipes* Stearns,

1883 (see Cordeiro et al. in press), an unusual species was encountered that was similar to species in that genus that were already known, but was consistently different from them in several characters. Although no recently collected specimens were available for molecular analysis, sufficient alcohol-preserved specimens were present at the NMNH to describe the new species and the new genus in which it is placed.

## Material and methods

All specimens are preserved in ethanol (70%) and deposited at the National Museum of Natural History. Reference material of all species of *Radicipes* was also examined (Cordeiro et al. in press). The terminology used in the description follows that of Bayer et al. (1983). Preparation of polyps for SEM to reveal sclerites includes short digestion (four seconds) of superficial coenenchyme, rinsing several times in distilled water, and drying at room temperature.

Abbreviations used in the text include: *Alb* – USFWS *Albatross*, L:W – length to width ratio of a sclerite, MCC – Monophyletic Chrysogorgiidae Clade *sensu* Pante et al. (2012), NMNH – National Museum of Natural History, Smithsonian Institution, USNM – United States National Museum (now known as the NMNH, but acronym still used for catalog numbers).

## Taxonomy

**Subclass Octocorallia Haeckel, 1866**

**Order Alcyonacea Lamouroux, 1812**

**Suborder Calcxonia Grasshoff, 1999**

## Family Chrysogorgiidae Verrill, 1883

Chrysogorgiidae Verrill 1883: 21.

Chrysogorgiidae: Versluys 1902: 2–4; Bayer 1956: F216; Bayer and Muzik 1976: 67–69 (key to genera); Bayer 1979: 876–878 (key to genera); Cairns 2001: 748–754 (synonymy); Pante and France 2010: 600 (key to genera); Watling et al. 2011: 68–74 (distribution maps of all genera); Pante et al. 2012: 1–12 (phylogenetic and bathymetric analyses).

**Type genus.** *Chrysogorgia* Duchassaing & Michelotti, 1864.

**Diagnosis** (after Cairns (2001) and Pante et al. (2012)). Calcaxonians having an unjointed, solid (non-spicular), concentrically layered scleroproteinous axis. The axial layers are usually smooth (not undulated) and thus not longitudinally grooved externally; the axis usually displays metallic or iridescent reflections. The colony may be branched or unbranched (flagelliform), arising from a root-like or discoidal, strongly

calcified holdfast. Polyps are contractile but not retractile, arranged in rows (uniserial, biserial or multiserial), but never in whorls. Sclerites predominantly flat, smooth scales, in some species warty rods and spindles.

**Remarks.** Fourteen genera have been assigned to the Chrysogorgiidae, but based on sequencing of three genes, Pante et al. (2012) have suggested that only six of these genera belong to Chrysogorgiidae *sensu stricto*, which they call the Monophyletic Chrysogorgiidae Clade, or MCC. They imply that the other genera may belong to as many as three other, as yet undescribed, families. The six genera of the MCC are keyed by Pante and France (2010) and their worldwide distributions plotted by Watling et al. (2011). They are further discussed by Pante et al. (2012) in the context of a phylogenetic analysis. *Flagelligorgia* is morphologically most similar to *Radicipes*, which is part of the MCC, but lacking material suitable for molecular analysis, the placement of *Flagelligorgia* in that family can only be a suggestion at this time. In fact, we did attempt to sequence four genes (*COI*, *mtMutS*, *28S* and *18S*) from specimens collected in 1964 with no results.

**Distribution.** Worldwide, 31–4492 m depths (Pante and Watling 2011: 6).

### *Flagelligorgia* gen. n.

<http://zoobank.org/0C142EEB-5AD6-4EE5-A654-F0C5DD669E79>

**Type species.** *Flagelligorgia gracilis*, here designated. Gender: feminine.

**Diagnosis.** Colonies unbranched (flagelliform), loosely coiled, attached by a holdfast; axis composed of undulating concentric layers (Figs 1C–E, 2D). Polyps arranged biserially. Body wall and coenenchymal scales elongate, smooth scales. Polyps lack an operculum.

**Remarks.** Until 1956 (Bayer 1956) the Chrysogorgiidae had been divided into three subfamilies, one being the Lepidogorgiinae Versluys, 1902, consisting of genera with an unbranched colony and lacking polyp opercula. However, the subfamily classification has been ignored for decades and is not supported by molecular evidence. Nonetheless, it is incumbent to compare *Flagelligorgia* to the four other unbranched chrysogorgiid genera. *Helicogorgia* Bayer, 1981, known only from the east coast of Africa at 66–775 m depth range, is unbranched but has its polyps arranged in a multiserial fashion on one side of the stem, a naked track displayed on the opposite side. Furthermore, its body wall scales are irregular plates and its coenenchymal scales are spindles. For all of these reasons *Helicogorgia* is easily distinguished from *Flagelligorgia*. Based on sequencing of three genes, Pante et al. (2012) indicate that *Helicogorgia* might constitute a family on its own, as sister to the Chrysogorgiidae. *Helicogorgia* was revised by Williams (1992), recognizing four species in the African coast.

*Chalcogorgia* Bayer, 1949, known only from its type locality off northwestern Cuba at 708 m depth, is also unbranched and has biserially arranged polyps, like *Flagelligorgia*, but differs in having eight triangular opercular scales on each polyp, and body wall scales shaped as irregularly shaped platelets. According to Pante et al. (2012:

8), based on “very limited data,” *Chalcogorgia* was suggested to ally with *Helicogorgia*, and thus also outside of the MCC.

*Distichogorgia* Bayer, 1979, known only from the Blake Plateau off Florida at 814 m depth, is unbranched and has biserially arranged polyps, but differs in having unique body wall scales consisting of two fans of longitudinally arranged, blade-like scales, one on each side of the polyp, interspersed with tiny pointed sclerites, similar to its coenenchymals. Pante et al. (2012) did not report sequencing data for this genus, but based on its biserially polyps, they suggested an affinity with *Helicogorgia* and *Chalcogorgia* in a family separate from the Chrysogorgiidae.

Perhaps most similar to *Flagelligorgia* is the genus *Radicipes* Stearns, 1883, consisting of 9–10 species (see Cordeiro et al., in press), which occurs worldwide at depths of 241–3580 m. *Radicipes* is unbranched but differs from *Flagelligorgia* in having uniserially arranged polyps, and a body wall and coenenchymal sclerites that are rod-shaped to compressed rod-shaped. Furthermore, chrysogorgiids (MCC), including *Radicipes*, are characterized by having an axis formed by non-undulated (smooth) concentric layers (Bayer 1956), which is not the case for *Flagelligorgia*. Based on molecular evidence Pante et al. (2012) placed *Radicipes* firmly in the Chrysogorgiidae clade (MCC), as the sister genus to *Chrysogorgia*. Lacking molecular evidence for *Flagelligorgia* (all specimens are quite old), it is not possible at this time to determine if it is allied with *Radicipes* in the Chrysogorgiidae (based on similarity of body wall sclerites) or the other cluster of genera including *Helicogorgia*, *Chalcogorgia* and *Distichogorgia* (based on polyp arrangement), which may constitute an as yet undescribed family.

**Distribution.** Off Southeastern United States from North Carolina to Florida, 196–567 m depths.

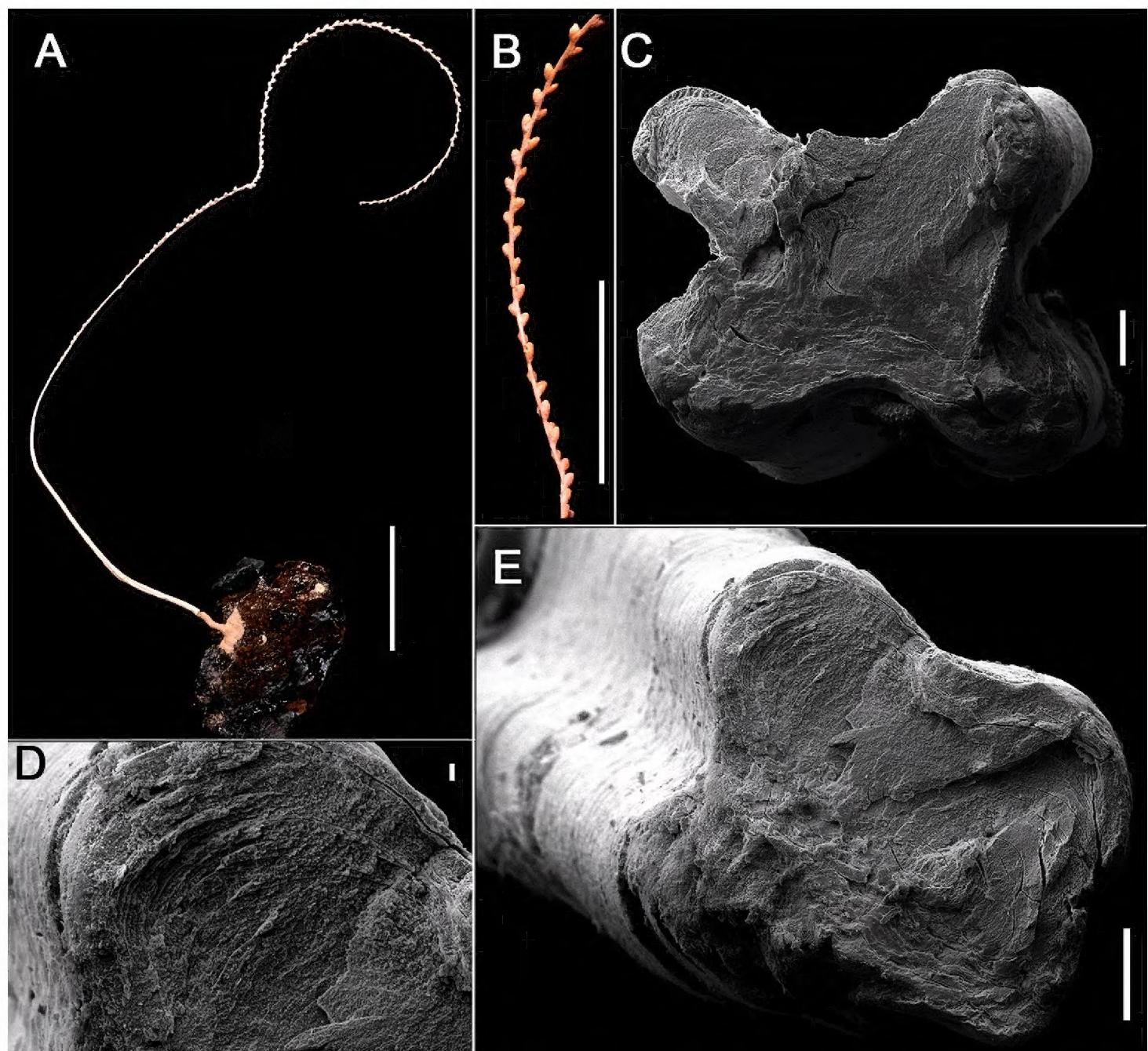
**Etymology.** The name is a combination of *flagellum* (Latin for small whip) and *gorgia* (a common octocoral suffix and once the name of the order Gorgonacea, the name derived from the mythical female monster, the Gorgon), in reference to the flagelliform nature of the colony.

### *Flagelligorgia gracilis* sp. n.

<http://zoobank.org/579269D2-B012-4C73-A854-E743F7154252>

Figs 1–4

**Material examined (Types).** Holotype: Alb-2666, 1 specimen now in two pieces, USNM 49503. Paratypes: Alb-2601, 34°39'15"N, 33°30'10"W, 196 m, 1 colony, USNM 16607, 18 October 1885; Alb-2602, 34°38'30"N, 75°33'30"W, 227 m, 1 colony, USNM 16821, 18 October 1885; Alb-2666, 30°47'30"N, 79°49'W, 494 m, 33 colonies, SEM stubs 2364–2367, USNM 14458, 5 May 1886; Alb-2667, 30°53'N, 79°42'30"W, 499 m, 40 colonies, USNM 14457, 5 May 1886; Gerda-179, 27°41'N, 79°11'W, 549–567 m, 9 colonies, USNM 57315, 1 July 1963; Megalopa, 11.2 km SSE of Carysfort Reef, Florida Keys, 205 m, 9 July 1950, 1 colony, USNM 51956, 9 July



**Figure 1.** Diagnostic characters of *Flagelligorgia gracilis* sp. n. **A** general view of the holotype (USNM 49503) attached to a rocky substrate **B** detail of the holotype showing the biserial arrangement of polyps **C,E** cross-section of the stem of the holotype showing its four rounded longitudinal cords **D** detail of undulating concentric layers of the stem in cross-section. Scale bars: **A**: 10 mm, **B**: 5 mm, **C, E**: 0.1 mm, **D**: 0.01.

1950; *Pillsbury*-105, 31°00'N, 79°42'W, 388–403 m, 2 colonies, USNM 57316, 27 July 1964; *Pillsbury*-197, 27°59'N, 79°20'W, 567–586 m, 2 colonies, USNM 52913, 11 August 1964.

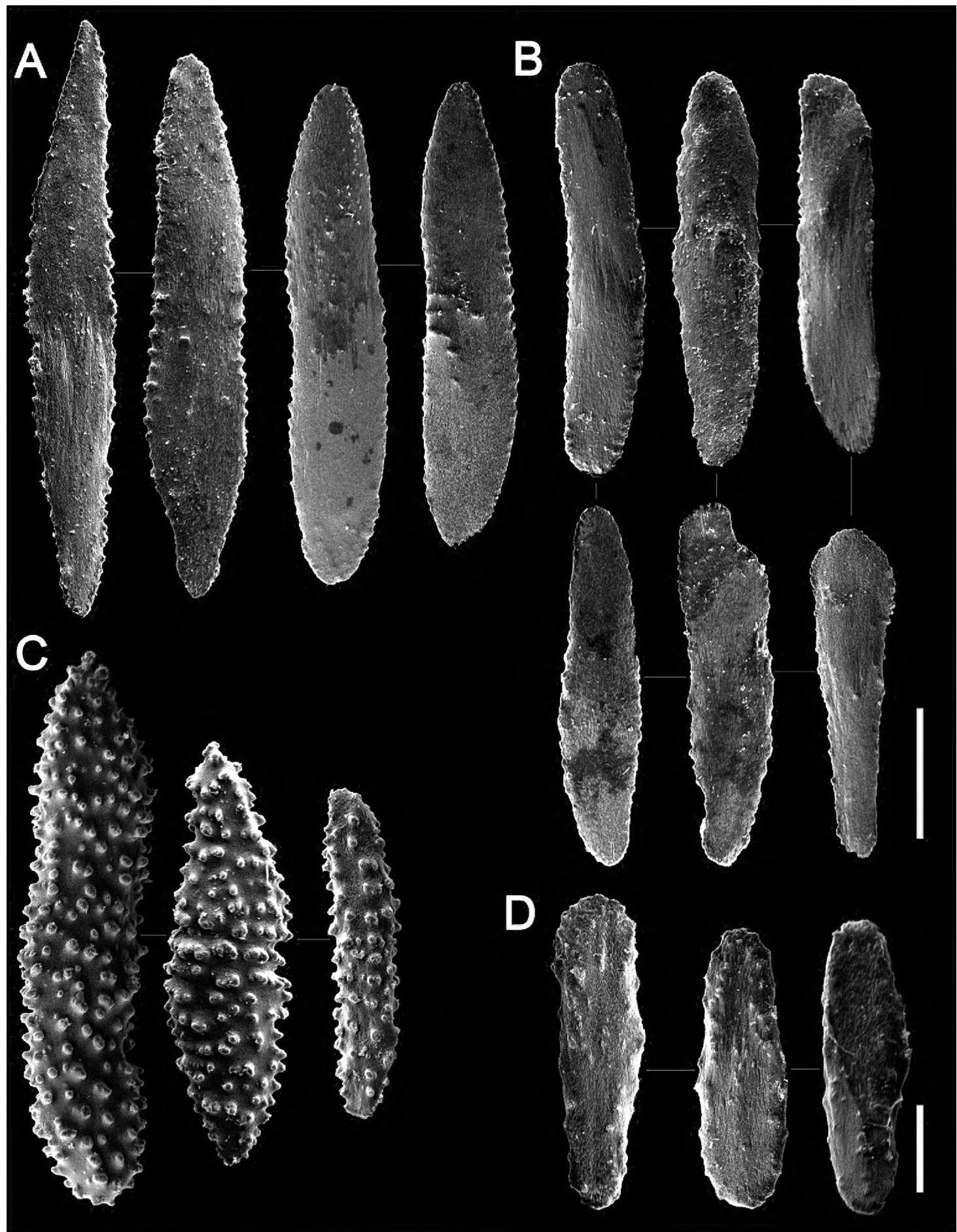
**Type locality.** 30°47'30"N, 79°49'W (continental slope off Georgia), 494 m depth.

**Description.** The colony is unbranched (flagelliform) and quite delicate, with an ascending clockwise spiral growth form (Fig. 1A, 2C). One of the largest specimens (the holotype) is 19 cm in length and only 1.1 mm in basal stem diameter. Colonies are attached to hard objects such as the deep-water coral *Lophelia pertusa* (Linnaeus, 1758), rocks, or echinoid tests, having a thin basal encrustation (holdfast) up to 7 mm in diameter; there are no root-like holdfasts. The axis is longitudinally grooved (Fig. 2D), resulting in four rounded longitudinal cords (1C, E), reflecting the underly-



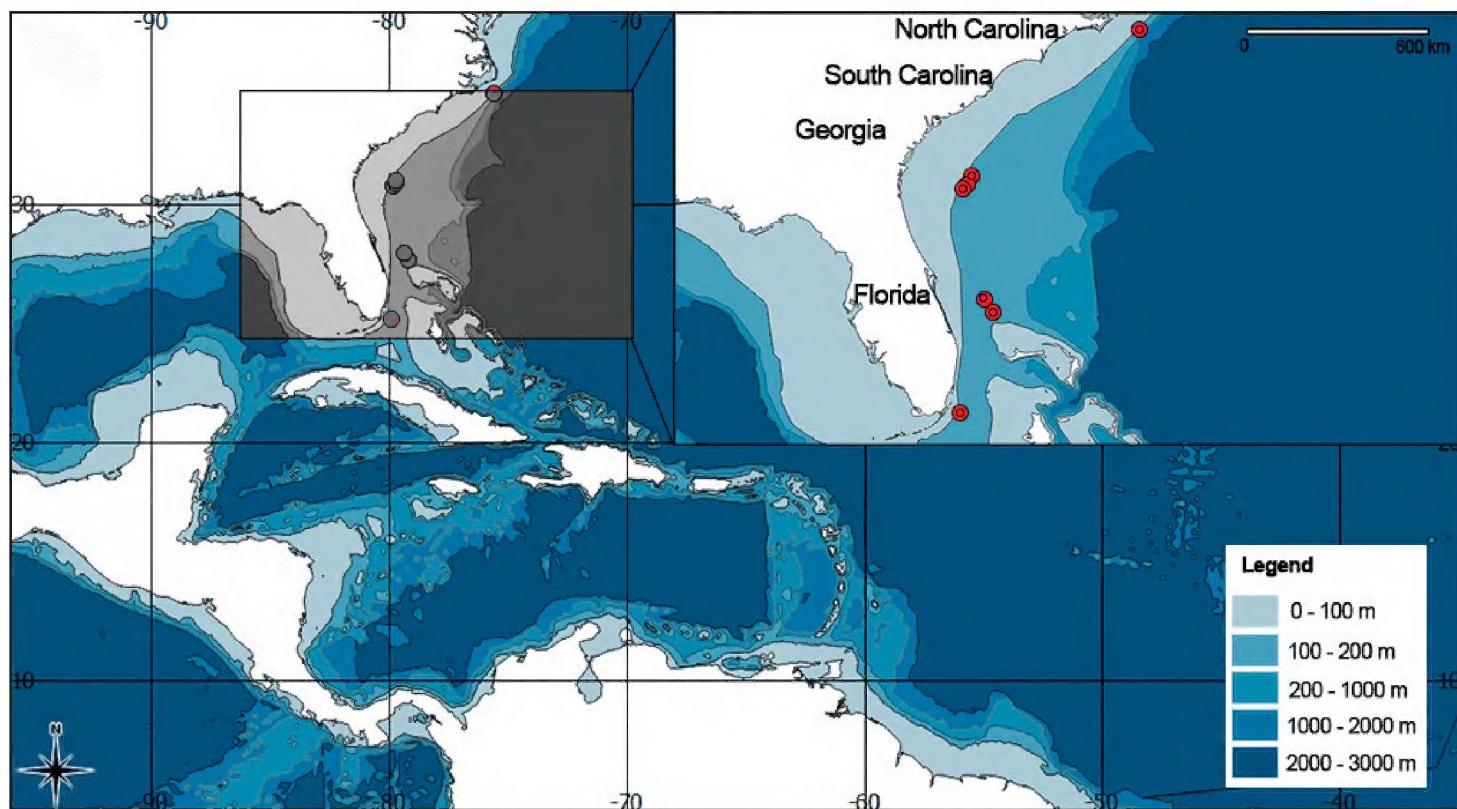
**Figure 2.** Detailed view of polyps and axis in *Flagelligorgia gracilis* sp. n. (USNM 14458) through Scanning Electron Microscopy. **A** stereo view of polyps **B** oral view of a polyp **C** stereo view of a polyp's abaxial side **D** stereo view of the axis. Scale bars: **A, C**: 0.2 mm, **B**: 0.04 mm, **D**: 0.01 mm.

ing undulated layers of scleroprotein (Fig. 1D), most easily seen in stem cross section. The axis is golden, the coenenchymal tissue usually pale brown to a dull yellow, in ethanol. Polyps are lacking from the proximal 45–50 mm of the stem, which is approximately 1/5–1/3 of the colony length, depending on its maturity (Fig. 1A). Polyps occur biserially, on opposite sides of the stem in alternating fashion (Figs 1B, 2A, C), and are relatively closely spaced such that 1.1–1.4 polyps occur per cm length. The polyps are 0.9–1.2 mm in length and are somewhat cigar-shaped (Fig. 2C), being slightly tapered distally; the greatest diameter (0.35–0.39 mm) is usually at mid-length. The body wall is covered with longitudinally oriented, elongate ( $L:W = 4.5–5.8$ ), imbricating scales (Fig. 3B) that measure 0.17–0.24 mm in length. They are rounded distally, have smooth lateral edges, and are quite thin (e.g., 13–15  $\mu\text{m}$  in thickness). Their outer and inner surfaces are smooth. Toward the end of the polyp are smaller scales



**Figure 3.** Sclerites of *Flagelligorgia gracilis* sp. n. (USNM 49503, holotype). **A** rods from coenenchyme **B** elongate rods from body wall **C** highly granular scales from first centimeters of the stem **D** tentacular scales. Scale bars: **A–C**: 0.05 mm, **D**: 0.02 mm.

associated with the tentacles (Figs 2B, 3D), similar in shape to the body wall scales but only 0.075–0.10 mm in length. Pinnular sclerites are virtually absent. Scales show concentric bands of interference colors in polarized light. There are no sclerites in the



**Figure 4.** Distribution map of *Flagelligorgia gracilis* sp. n.

axial sheath of coenenchyme. The outer coenenchymal scales (Fig. 3A) are also longitudinally arranged on the stem, elongate ( $L:W = 4.8\text{--}7.9$ ), and imbricate. They have pointed tips and their lateral edges are slightly serrate, each serration up to 5  $\mu\text{m}$  in height; they are also quite thin, and their faces are also smooth. Coenenchymal scales on the first few centimeters of the stem are highly granular (Fig. 3C).

**Remarks.** As in other unbranched octocorals, such as species of *Radicipes*, some specimens (e.g., from USNM 14458, USNM 51956 and USNM 14457) host commensal ophiuroids. Other octocoral species found at the same stations at which *Flagelligorgia* were collected include: *Plumarella aurea* (Deichmann, 1936), *Plumarella pourtalesii* (Verrill, 1883), *Plumarella dichotoma* Cairns & Bayer, 2004, *Swiftia casta* (Verrill, 1883) and *Callogorgia americana* Cairns & Bayer, 2002.

**Distribution.** Southeastern coast of United States from off Outer Banks, North Carolina to off Carysfort Reef (near Key Largo, Florida) (Fig. 4), 196–567 m depths.

**Etymology.** Named *gracilis* (Latin for slender, gracile), in allusion to the very slender aspect of the colony.

## Acknowledgments

We are grateful to the reviewers Dr. Eric Pante and Dr. Scott France and to Dr. Bert Hoeksema (editor), for their valuable suggestions for the improvement of this manuscript. The second author thanks the Smithsonian for a Short Term Visitor grant, which facilitated the accomplishment of this study. RTSC was also supported by FACEPE (IBPG-0558-2.04/13), Brazil.

## References

- Bayer FM (1949) Chalcogorgiinae, a new subfamily of Chrysogorgiidae (Coelenterata: Alcyonaria), and a description of *Chalcogorgia pellucida*, new genus and new species, from the Straits of Florida. *Journal of the Washington Academy of Sciences* 39(7): 237–240. <http://biodiversitylibrary.org/page/39703539>
- Bayer FM (1956) Octocorallia. In: Moore RC (Ed.) *Treatise on Invertebrate Paleontology*, Part F. Coelenterata. Geological Society of America and University of Kansas Press, Lawrence, Kansas, 163–231.
- Bayer FM (1979) *Distichogorgia sconsa*, a new genus and new species of chrysogorgiid octocoral (Coelenterata: Anthozoa) from the Blake Plateau off northern Florida. *Proceedings of the Biological Society of Washington* 92(4): 876–882. <http://biodiversitylibrary.org/page/35514597>
- Bayer FM (1981) Key to genera of Octocorallia exclusive of Pennatulacea (Coelenterata, Anthozoa), with diagnosis of new taxa. *Proceedings of the Biological Society of Washington* 94(3): 902–947. <http://biodiversitylibrary.org/page/34607413>
- Bayer FM, Muzik KM (1976) New genera and species of the holaxonian family Chrysogorgiidae (Octocorallia: Gorgonacea). *Zoologische Mededelingen* 50(5): 65–90. <https://repository.si.edu/handle/10088/973>
- Bayer FM, Grasshoff M, Versteegh J (1983) Illustrated Trilingual Glossary of Morphological and Anatomical Terms Applied to Octocorallia. E. J. Brill/Dr. W. Backhuys, Leiden, 75 pp. <https://repository.si.edu/handle/10088/6237>
- Cairns SD (2001) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 1: The genus *Chrysogorgia* Duchassaing & Michelotti, 1864. *Proceedings of the Biological Society of Washington* 114(3): 746–787. <https://repository.si.edu/handle/10088/2462>
- Cairns SD, Bayer FM (2002) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 2: the genus *Callogorgia* Gray, 1858. *Proceedings of the Biological Society of Washington* 115: 840–867. <https://repository.si.edu/handle/10088/7542>
- Cairns SD, Bayer FM (2004) Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 2: the genus *Plumarella* Gray, 1870. *Proceedings of the Biological Society of Washington* 117(4): 447–487. <https://repository.si.edu/handle/10088/7495>
- Cairns SD, Bayer FM (2009) Octocorallia (Cnidaria) of the Gulf of Mexico. In: Felder DL, Camp DK (Eds) *Gulf of Mexico—origins, waters, and biota*, vol 1, Biodiversity. Texas A&M Press, Texas, 321–331. <https://repository.si.edu/handle/10088/19156>
- Cordeiro RTS, Cairns SD, Perez CD (in press) A revision of the genus *Radicipes* Stearns, 1883 (Anthozoa: Octocorallia: Chrysogorgiidae). *Zootaxa*.
- Deichmann E (1936) The Alcyonaria of the Western part of the Atlantic Ocean. *Memoirs of the Museum of Comparative Zoology* 53: 253–308. <http://ia801409.us.archive.org/22/items/memoirsofmuseumo53harv/memoirsofmuseumo53harv.pdf>
- Duchassaing P, Michelotti J (1864) Supplément au mémoire sur les corallaires des Antilles. *Memorie della Reale Accademia delle Scienze di Torino* 2(23): 97–206. <http://biodiversitylibrary.org/page/36388394>

- Grasshoff M (1999) The shallow-water gorgonians of New Caledonia and adjacent islands (Coelenterata: Octocorallia). *Senckenbergiana Biologica* 78: 1–245.
- Haeckel E (1866) Generelle morphologie der Organismen, vol. 2. Verlag von Georg Reimer, Berlin. <https://doi.org/10.1515/9783110848281>
- Lamouroux JV (1812) Extrait d'un mémoire sur la classification des polypiers coralligènes non entièrement pierreux. *Nouveau Bulletin des Sciences, Société Philomathique de Paris*, 3(63): 181–188.
- Linnaeus C (1758) *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata.* Holmiae, Laurentii Salvii, 824 pp. <http://biodiversitylibrary.org/page/726886>
- Pante E, France SC (2010) *Pseudochrysogorgia bellona* n. gen., n. sp.: a new genus and species of chrysogorgiid octocoral (Coelenterata, Anthozoa) from the Coral Sea. *Zoosystema* 32(4): 595–612. <http://dx.doi.org/10.5252/z2010n4a4>
- Pante E, Watling L (2011) *Chrysogorgia* from the New England and Corner Seamounts: Atlantic–Pacific connections. *Journal of the Marine Biological Association of the United Kingdom* 92(5): 911–927. <https://doi.org/10.1017/S0025315411001354>
- Pante E, France S, Couloux A, Cruaud C, McFadden CS, Samadi S, Watling L (2012) Deep-sea origin and in-situ diversification of chrysogorgiid octocorals. *PLoS One* 7(6): e38357. <http://dx.doi.org/10.1371/journal.pone.0038357>
- Perez CD, Neves BM, Cordeiro RTS, Williams GC, Cairns SD (2016) Diversity and Distribution of Octocorallia. In: Goffredo S, Dubinsky Z (Eds) *The Cnidaria, Past, Present and Future. The world of Medusa and her sisters.* Springer, 109–123. <http://dx.doi.org/10.1007/978-3-319-31305-4>
- Stearns REC (1883) Descriptions of a new genus and species of alcyonoid polyp, from Japanese waters, with remarks on the structure and habits of related forms, etc. *Proceedings of the United States National Museum* 6: 96–101. <https://repository.si.edu/handle/10088/12541>
- Verrill AE (1883) Report on the Anthozoa, and on some additional species dredged by the “Blake” in 1877–1879, and by the U.S. Fish Commission steamer “Fish Hawk” in 1880–82. *Bulletin of the Museum of Comparative Zoology* 11: 1–72. <http://biodiversitylibrary.org/page/4621758>
- Versluys J (1902) Die Gorgoniden der Siboga-Expedition. I. Die Chrysogorgiiden. *Siboga Expeditie* 13: 1–120.
- Watling L, France S, Pante E, Simpson A (2011) Biology of deep-water octocorals. In: Lesser M (Ed.) *Advances in Marine Biology*. Elsevier Academic press, London, 41–122. <http://dx.doi.org/10.1016/B978-0-12-385529-9.00002-0>
- Williams GC (1992) The Alcyonacea of southern Africa. Gorgonian octocorals (Coelenterata, Anthozoa). *Annals of the South African Museum* 101(8): 181–296. <http://biodiversitylibrary.org/page/40683324>